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MASTER OF MILITARY STUDIES

TITLE: The Marine Corps Assault Support Community: The Requirement to Develop and Maintain the Capability to Operate in the Mountainous Climate and Place

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Executive Summary

Title: The Marine Corps Assault Support Community: The Requirement to Develop and Maintain the Capability to Operate in the Mountainous Clime and Place

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Thesis: As a major subordinate element of the MAGTF, the Air Combat Element (ACE), specifically the helicopter and tilt-rotor assets of the assault support community, must develop and maintain resident competencies to conduct helicopter-borne operations in the mountainous operational environment.

Discussion: The U.S. Marine Corps has operated in mountainous environments since near its inception. Whether in the Acacus Mountains of Libya or the Hindu Kush of Afghanistan, Marines have conducted scores of combat operations in this challenging and complex environment. However, the Marine Corps does not currently dedicate resources and time to establish robust and consistent capabilities across the Marine Air Ground Task Force (MAGTF) to operate in this environment. With the first employment of the helicopter during the Korean War, a growing reliance on this asset has evolved as a substantial means of mobility and fire power. Compared to all other operational environments, successful helicopter support to operations in the mountains is not only a matter of ability, but necessity. Given the extreme nature of the mountainous environment (composed of rugged terrain, high altitude, and drastic changes in weather), the location of mountainous regions across the globe, and the future national security concerns, the Marine Corps must be prepared to deploy and operate at any time in these areas. The Marine Corps assault support community, in addition to the entire MAGTF, must mitigate the current lack of capability.

Conclusion: As a major subordinate element of the MAGTF, the Air Combat Element (ACE), specifically the helicopter and tilt-rotor assets of the assault support community, must develop and maintain resident competencies to conduct helicopter-borne operations in the mountainous operational environment. The Marine Corps must recognize and commit to this necessity across all elements of the MAGTF.

DISCLAIMER

THE OPINIONS AND CONCLUSIONS EXPRESSED HEREIN ARE THOSE OF THE INDIVIDUAL STUDENT AUTHOR AND DO NOT NECESSARILY REPRESENT THE VIEWS OF EITHER THE MARINE CORPS COMMAND AND STAFF COLLEGE OR ANY OTHER GOVERNMENTAL AGENCY. REFERENCES TO THIS STUDY SHOULD INCLUDE THE FOREGOING STATEMENT.

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Preface

This project actually began in the summer of 2008. I was assigned as the Air Officer to the Marine Corps Mountain Warfare Training Center (MWTC), Bridgeport, California serving in that role until the summer of 2011. To a lesser degree, it started as I began thinking about the Marine Corps' assault support community capabilities in various operational environments. As an AH-1W Super Cobra pilot, I noticed atrophy in skill sets and capabilities within my own squadron resulting from multiple deployments to Iraq compared to those prior to that time period.

While at MWTC, I was responsible for all aviation training and to integrate aviation support in the training of ground troops. I soon realized that Marine Corps aircraft rarely trained at this awesome venue and even more rarely, provided support to the Marines on the ground. I understood that there were multiple variables involved such as resource availability, time, and other priorities causing me to rely primarily on Army and Navy aviation that was eager to fill the role. Perhaps the hardest pill to swallow was the lack of commitment to and recognition of the need for the capability to operate in this complex, compartmentalized, mountainous terrain at altitude. I attempted over the course of three years to push this concern on behalf of not only Marine Corps Aviation but that of my Commander who stressed the need for synergistic training across the MAGTF in the mountainous environment. This paper is an attempt to reinforce these efforts.

I would like to acknowledge the assistance of several individuals who were instrumental to this paper. First, I would like to thank Colonel Norman Cooling, USMC for his steadfast guidance and mentorship which enabled me to grow further from an aviator into a more knowledgeable and well-rounded MAGTF Officer. Secondly, I would wish to thank Colonel Mark Strong, USA for his leadership and instructorship as my Military Advisor during this process which allowed me to gain a larger perspective in the strategic and operational environments through the overall course program of instruction. Additionally, I would like to thank Dr. Paul Gelpi for his mentorship, research assistance, and critical inputs. Most importantly, I want to acknowledge my wife Elizabeth and sons Aiden, Brendon, and Conlee for their unwavering support to all that I embark upon.

*"Helicopter aviators are managing more complex aircraft and systems in an increasingly lethal world and can be easily distracted from their ability to pilot an aircraft; nowhere is this more telling than in the mountains where the environment is as lethal as any weapon on the battlefield."*¹

-U.S. Army, High Altitude Aviation Training Site

*"If you can operate successfully in complex, compartmentalized, and mountainous terrain at altitude, you can operate successfully anywhere. The opposite is NOT the case."*²

*-Colonel Norman Cooling, USMC, Former Commanding Officer
Marine Corps Mountain Warfare Training Center*

Introduction

The mountainous operational environment presents substantial challenges to the Marine Air Ground Task Force (MAGTF) across all six of the warfighting functions and throughout the entire spectrum of conflict.³ This paper will examine the strategic, operational, and tactical necessity for the Marine Corps to possess the resident capabilities to operate in this demanding environment and eventuality that a MAGTF will be deployed to a mountainous region.

Although not a comprehensive review of MAGTF operations, it is necessary to discuss functions in the mountainous environment at the MAGTF level in order to provide an overall framework for discussion. Additionally, the dynamic and formidable characteristics of the mountainous operational environment with associated implications on helicopter-borne operations will be illustrated. Furthermore, an explanation of the current state of Marine assault support capabilities to operate in the mountainous environment and recommendations to rectify the deficiency will be presented. Ultimately, this paper will demonstrate that as a major subordinate element of the MAGTF, the Air Combat Element (ACE), specifically the helicopter and tilt-rotor assets of the assault support community, must develop and maintain resident competencies to conduct helicopter-borne operations in the mountainous operational environment.

Requirement for the Capability

Mountainous regions, often associated with extremes in weather conditions, complexity of terrain, and high altitudes, are located worldwide and are within littoral regions in many instances (See Appendix A). Mountains cover approximately 27 percent of the world's land surface with 22 percent of the total global population residing in these areas.⁴ They exist on each of the seven continents and on most large islands. North and South America, Europe, Asia, and Africa all have great and expansive mountain ranges as well as isolated mountainous regions. Variations in physical and environmental characteristics are vast including dry and barren desert regions with temperatures ranging from extreme heat in the summer to extreme cold in the winter, lush tropical regions with heavy seasonal rains and minimal variations in temperature; and expansive formations with glaciated peaks with snow cover year-round.

The U.S. Department of Defense (DOD) has set forth guidance through the *Quadrennial Defense Review Report 2010* stating that, "the wars we are fighting today and assessments of the future security environment together demand that the United States retain and enhance a whole-of-government capability to succeed in large-scale counterinsurgency, stability, and counterterrorism operations in environments ranging from densely populated urban areas and mega-cities, to remote mountains, deserts, jungles and littoral regions."⁵ Amplified by the post-9/11 era and concurrent with the restructuring of the U.S. Armed Forces towards a capabilities based force underscores the necessity of having the ability to operate effectively and consistently in the mountainous operational environment. According to Michel Savini, Assistant Director-General of the United Nations Food and Agriculture Organization, "Conflicts can erupt anywhere, but it is an alarming fact that in the last fifty years conflicts in mountain regions have greatly increased. Violent conflicts are now almost twice as likely to occur at high altitude."⁶

The principal mountain ranges of the world lie along broad belts encircling the Pacific basin and then lead westward across Eurasia into North Africa with secondary chains, though no less rugged, lying along the Atlantic margins of the Americas and Europe.⁷ The Marine Corps Intelligence Activity's *Midrange Threat Estimate: 2005-2015* identifies 20 states as "states of interest" with all 20 located within the "Arc of Instability", and 16 of these 20 states of interest have regions with elevations equal to or greater than 8,000 feet and average temperatures of 40 degrees Fahrenheit and below (See Appendix B).⁸ The "Arc of Instability" refers to the political, military, and economical interconnections between unstable nation states in which destabilization within one of these interconnectors would have major ramifications in adjacent nation states.⁹ The current and projected threats in many of these countries center on small, irregular forces operating in rugged compartmentalized terrain that will leverage the inherent advantages that mountainous terrain and weather provide in order to marginalize or negate U.S. technological advantages. Relevant to the current national security condition that the United States faces with Iran and the surrounding region, a formidable operating environment exists. Iran's geographical composition consists of over 4,700 miles of coastline with one sixth of the country at elevations over 6,500 feet and with expansive regions in excess of 10,000 feet exhibited throughout a series of massive mountain ranges spanning from border regions of Russia, Turkey, and Iraq to Pakistan and Afghanistan including significant escarpments at the Strait of Hormuz.¹⁰

Within these regions, it is unlikely that the Marine Corps will find itself engaging in large-scale conventional warfare; nevertheless, the capability to do so must be maintained as the potential remains. It is most likely that the Corps' missions in these regions will include major regional contingencies, counter-insurgency operations, combating terrorism, non-combatant

evacuation operations, humanitarian operations, and peace keeping operations.¹¹ Regardless of the mission, the full capabilities of a MAGTF will be utilized. For twenty-first century U.S. Marines, it is not a question of if they will be required to operate in mountainous environments but when and how often. Consequently, the Marine Corps must commit to resourcing this eventuality.

Marine Corps Vision 2025, describes the Marine Corps of the future as the “Nation’s expeditionary force of choice prepared to ‘live hard’ in uncertain, chaotic, and austere environments and must be organized, trained, equipped, and deployed in inhospitable conditions. In addition, the Marine Corps will prepare to conduct operations against hybrid threats in complex environments such as urban littorals, mountainous terrain, and dense jungles.”¹² The Marine Corps is currently planning, evident by force structure changes and the standing up of five Marine Expeditionary Brigade Headquarters, for contingency capable MAGTFs in five prioritized regions.¹³

Within each of these five geographic locations extensive mountainous regions exist, and these MAGTFs, along with their major supporting elements, must be prepared and maintain a continuous capability and high state of readiness in order to operate effectively and conduct operations across the spectrum of conflict within these mountainous regions. Although, operations in this environment will present sizable challenges to the entire MAGTF, the ACE with its assault support assets will be called upon to mitigate mobility and fire support constraints despite environmental impacts. Goals of the future Marine Corps will allow greater support to MAGTF and Joint Force Commanders by maintaining the capacity and capabilities to conduct amphibious operations across the range of military operations.¹⁴ Many military circles, even those within the Marine Corps, default to amphibious operations being near exclusively

synonymous with over-the-shore movement by a surface means and ship-board operations. An assessment of the littorals and areas adjacent suggest a different eventuality. Access to potential contingency locations in mountainous regions will likely be conducted by helicopter-borne forces, as the only capable means of entry, and may be executed by amphibious forces. (See Appendix B). This scenario was executed by the 22d Marine Expeditionary Unit in the conduct of operations in Afghanistan in 2004.¹⁵ Impacts on helicopter-borne operations in the mountainous environment can be varied and immense. However, effective actions are still able to be performed within these constrictions, and helicopters will be utilized to the maximum extent able in support of MAGTF objectives. The Marine Corps must commit the requisite resources to establish a capability to conduct mountain warfare operations and recognize helicopters as potentially the only plausible means of mobility and fire support.¹⁶

The Mountainous Operational Environment

The Department of Defense (DOD) defines an operational environment as “a composite of the conditions, circumstances, and influences that affect employment capabilities and bear on the decisions of the commander.”¹⁷ The mountainous operational environment is quite multifarious and is composed of interconnected attributes of terrain, altitude, weather, and climate. A multitude of interrelated variables persist and often overlap with a number of operational environments such as desert, mountainous, and cold region. A single source, distinct, and encompassing doctrinal or reference definition does not exist. Marine Corps Warfighting Publication information and Training and Readiness (T&R) Manual condition requirements are not synchronized, and often do not match. Defining a common standard is essential in the development of training, operational planning, and eventual execution of operations in this unique environment. However, this paper will not focus on this deficiency, but

simply point out that disparities exist among various doctrinal, reference, and training publications. Although commonality among definitions and characterizations needs to be refined and achieved, the take away is having an understanding of the enormous impact that the mountainous environment imparts on operations.

The U.S. Army and Marine Corps expend a great deal of effort outlining physical and environmental characteristics as well as specifying classifications of mountainous terrain. The overall nature of the mountainous operational environment is that of ruggedness, limited accessibility, and austerity. Recognition of the difficulties that this environment presents and likely potential to operate within it is paramount to future Marine Corps success. Mountain Warfare Operations, in the near future, will be established as a separate operational environment equal to that of jungle, urban, and amphibious as provided by the final draft of the combined Marine Corps Warfighting Publication (MCWP 3-35.1) and U.S. Army Tactics Techniques and Procedures Manual (ATTP 3-97.6), *Mountain Warfare Operations*, that was signed in February of 2011. For the purposes of defining and describing the mountainous operational environment, this draft publication will largely be utilized as it contains the same baseline information as the preceding and current U.S. Army Field Manual (FM3-97.6), *Mountain Operations*.

Physical Characteristics

For the purposes of U.S. Army and Marine Corps military operations, mountains are simply defined as landforms that rise more than 500 meters above the surrounding plain.¹⁸ Marine Corps Warfighting Publication (MCWP 3-35.1), *Mountain Warfare Operations*, defines mountainous terrain as rising abruptly from plains to form a giant barrier or ascend gradually as a series of parallel ridges extending for great distances, consisting of varying combinations of

isolated peaks, rounded crests, eroded ridges, high plains cut by valleys, gorges, and deep ravines with the commonality of all of the described terrain being rugged.¹⁹ Mountainous terrain will have slopes that generally vary between 15 and 45 degrees, contain cliffs and other rocky precipices that may be near vertical or overhanging, present several types of surface composition and obstacles, and will often be associated with extreme fluctuations in altitude.²⁰ Variations in slope cover can include rock, grass, large trees, snow, and ice all of which can be present in a single mountain range changing rapidly with elevation and latitude differences.

The Marine Corps classifies mountains according to elevation, operational terrain levels, and dismounted mobility and skill requirements. General classifications define local relief as either low or high mountains based on elevation with “low mountains” as 1000 to 3000 feet and peaks below the timberline and “high mountains” exceeding 3000 feet with barren alpine zones above the timberline.²¹ Specific classifications utilize elevation defined by height of immediate terrain in reference to sea level. Operational terrain levels are classified as Level I, II, and III and are based less on elevation and more so on mobility constraints.²² Dismounted mobility and skill requirements describe classes of terrain, mobility requirements, and skill levels required for foot-mobile troops and are not relevant to the scope of this paper.

Specific Classifications (Elevation – MSL)	
Very Low	< 500 ft
Low	500 – 1,000 ft
Moderately Low	1,000 – 3,000 ft
Moderately High	3,000 – 6,000 ft
High	6,000 – 10,000 ft
Very High	> 10,000 ft

Figure 1

Operational Terrain Levels	
Level I	Bottom of valleys along main lines of communication
Level II	Between valleys and shoulders of mountains; contains secondary lines of communication
Level III	Dominant terrain of summit regions

Figure 2

Lieutenant Colonel Scott Pierce, USMC simplifies what defines the mountain and cold weather operational environment and provides a working military definition in *Mountain and Cold Weather Warfighting: Critical Capability for the 21st Century*. This definition is less inclusive, discriminating, and provides greater utility. It is also described within various aspects of current, and pending, U.S. Army and Marine Corps publications: “The mountain/cold weather environment is characterized by one or more of the following attributes: persistent ambient air temperatures below -5°F (-21°C); persistent mean snow depths of approximately 20 inches significant glaciated terrain; rugged, severely compartmented terrain, combining mean slope angles of 45 degrees with elevation differentials exceeding 1000 feet with peaks exceeding 8000 feet above sea level.”²³ This definition provides for an inclusive description of mountainous and cold weather operational environments and it must be inferred that many of these conditions exist at lower elevations within the specific terrain and temperature components. These areas can be located in predominately hot and arid conditions as well as cold and flat higher elevated plateaus. The physical and environmental characteristics collectively consist of a multitude of factors and pose considerable challenges in the conduct of mountain operations.

Environmental Characteristics

Most mountainous regions exhibit at least two different climatic zones: a zone at low elevations and another near the summit regions.²⁴ Mountain weather changes rapidly and displays a broad range of potentially extreme conditions. Environmental conditions change markedly with elevation, latitude, and exposure to atmospheric winds.²⁵ Mountain weather can be erratic, unpredictable, and change within very short distances. Compounding variables of temperature, wind velocity and direction, and precipitation, each having significant individual

and collective effects, contribute to the imprecision of meteorological forecasting in mountainous regions.

Marine Corps Warfighting Publication (MCWP 3-35.1), *Mountain Warfare Operations*, integrates elements of the Marine Corps Warfighting Reference Publication (MCRP 3-35.1D), *Cold Region Operations* in the categorization of temperature bands. However, each operational environment is doctrinally separate.

Category	Temperature
Wet Cold	20°F to 39°F
Dry Cold	-4°F to 19°F
Intense Cold	-25°F to -5°F
Extreme Cold	-40°F to -26°F

Figure 3

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These categories describe temperature conditions at a point location on the ground and do not reflect or relate temperature as a contributing factor to any other environmental influences.

These temperature ranges are markers that assist to define equipment and support requirements.

Higher elevations in arid and desert type conditions are not considered with primary focus on colder climatic temperatures. On average, temperatures drop 3-5°F per 1,000 feet of elevation gain; temperatures can drop as much as 1°F for every 300 feet in conditions of high humidity and as much as 1°F for every 150 feet in very dry conditions.²⁷ With changes in temperature as a product of altitude gain, air pressure is also decreased resulting in lower air density.

Temperature is the basis for all air movement locally or system wide, creates the differential

pressures that stir motion, creates high and low pressures, and initiates thermals and downdrafts that ultimately result in the tremendous diversity and severity of weather in this environment.²⁸

In mountainous terrain, winds are categorized in three types: prevailing, local or valley (convective), and surface winds.²⁹ Prevailing winds are the constant higher altitude winds, 2,000 to 3000 feet above ground level, generally flowing from west to east in the Northern Hemisphere and opposite in the Southern Hemisphere with velocities influenced by air pressure and temperature. The shape and elevation of terrain affects the velocity of airflows. Deep and narrow valleys and steep walled canyons create a natural venturi effect: air flows funneled through the terrain that typically move upslope during the day with increased temperatures and down slope with decreased temperatures at night.³⁰ Convective winds rise and fall based on cooling and warming cycles creating turbulence as airflow impacts terrain and can be erratic and difficult to determine, and surface winds are the result of either prevailing winds, convective winds, or the interaction of both.³¹ In mountainous terrain, the contact of these winds with terrain dictates the velocity and direction of surface winds at exact points on the ground and will typically increase in speed as altitude increases.³² Terrain impacts on winds are significant with velocities increasing and direction changing when forced over ridges and peaks, orographic lifting, or when colliding and moving around terrain.³³ The rapid rise and interaction of air masses over mountains creates distinct local weather patterns with precipitation increasing with elevation.³⁴

Major mountain ranges force air masses and storm systems to deposit sizeable amounts of precipitation as air passes over peaks and ridgelines with the prevailing winds and elevation of the terrain determining the severity of the overall effects.³⁵ Maximum precipitation occurs near 6,000 feet elevation with the predominance of accumulation of rain, ice, or snow on the

windward side; and depending on the specific region, snow may be present year-round at elevations above 5,000 feet.³⁶ Sizeable amounts of snow fall may occur resulting in and varying densities and stabilities of snow packs. Additional weather conditions as a result of precipitation that may be encountered include fog, ice fog, blizzard and white out conditions, temperature inversions, and avalanches.

Effects on Helicopter Performance and Capabilities

Conducting mountain warfare operations is arduous with a multitude of variables involved that impact aviation functions. The Marine Corps assault support inventory consists of a several aircraft types. For the purpose of this paper, helicopter, rotary wing, and tilt-rotor aircraft will be inclusively referred to as helicopter(s), collectively as assault support assets, and conducting helicopter-borne operations unless otherwise specified. Tilt-rotor aircraft will be regarded as helicopters while in the helicopter mode or configuration. Assault support refers to a mission type or elements of the ACE utilizing these assets. Regardless of the platform, effects of the environmental conditions on all helicopters are similar with individual aircraft capabilities varying among specific aircraft types, configurations, and engine and transmission outputs. In addition to baseline helicopter capabilities, conditions and variations of altitude, temperatures, humidity, and other environmental factors have substantial effects.

Operational performance and capabilities are a function of engine performance, power available, and aircraft performance, power required, both of which are significantly influenced by environmental conditions.³⁷ Power required is how much engine power a helicopter will need to maintain flight in a given environment, and power available is how much power a helicopter engine is able to produce for the given environmental conditions.³⁸ In the mountainous

environment, helicopters will likely operate at or near maximum capability. The most influential factors affecting helicopter capabilities and performance operating in this condition are variations in density altitude, wind direction, and wind velocities.

Density altitude is pressure altitude, standard barometer reading, that is corrected for temperature and humidity.³⁹ An increased density altitude results in more power required to lift a given weight, less effective control inputs, greater maneuver space requirements, problems with aircraft controllability, and reduced operating airspeeds.⁴⁰ Density altitude is the primary factor in helicopter performance, can change significantly throughout an operating area, and can be deceiving as planning factor. For example, a landing zone indicated at 6,000 feet mean sea level (MSL) on map can have a pressure altitude of 6,500 feet, standard barometric reading, and a density altitude of 10,460 feet, inclusion of temperature and humidity factors. The result is a decrease in effectiveness of the main rotor blades providing lift, the tail rotor, if equipped, providing directional control, and greater engine power requirements all due to the decrease of air density.⁴¹ This type of condition will have significant impacts on the aircraft's capabilities to include combat radius, cargo and ordnance capacities, external lift capacities, and maneuverability.⁴² This example is not exclusive to the mountainous environment. The same conditions can be experienced in flat desert conditions at near sea level where temperatures are exceedingly hot. However, these conditions typically remain constant for long periods of time, over large areas, and may be devoid of significant terrain effects. As a result, operational capabilities and performance are more predictable. Due to the extreme nature and rapid changes in weather, temperature, and altitude in the mountains and potentially all within a small geographic area; planning and execution requires detailed attention as the margin for error is reduced significantly.⁴³

Changes in wind velocity and direction can often be measured in seconds or feet producing levels of turbulence that make flight operations extremely hazardous.⁴⁴ Aircraft will experience fluctuations in tail, head, and cross wind velocities and direction based on wind interactions with terrain. It is also possible to experience a head and tail wind simultaneously at the same location as in a pinnacle landing on a high mountain peak or ridgeline. Wind effects alone are not concerning until they exceed the operating limitations of an aircraft or go undetected and subsequently unmitigated by aircrew. The composition of mountainous terrain presents major challenges in detecting wind velocities and direction as aircraft have no onboard sensors to detect wind, and aircrews are reliant on training, experience, visual cues, and aircraft performance indicators. Aircraft controllability, ingress and egress directions, and airspeeds will all be affected. The ability to conduct accurate wind and terrain analysis is perhaps the single greatest requirement to successful helicopter operations in the mountains.⁴⁵

Tactical Implications

Helicopters provide MAGTF and Joint Force Commanders with tremendous maneuver and fire support capabilities that enable the rapid concentration of combat power. However, all subordinate commanders engaged in operations in the mountainous operational environment must be cognizant of the effects of terrain, weather, and elevation on helicopter-borne operations. This is not relegated to simply the limitations of individual aircraft capabilities imposed by the environmental conditions, but to all components of an operation. The greatest impact is primarily on mobility and fire support. Ground mobility via mechanized and armored forces may be limited to non-existent. Poorly maintained or non-existent road networks, steep slopes, boulders, and snow packs are some factors that will force an increased emphasis on alternate means of mobility and fire support, foot-mobile with organic weapon systems and aviation. This

results in an increased reliance on helicopter-borne support to execute functions such as tactical movements, casualty and medical evacuations, resupply, and fire support.

The combined effects of environmental factors such as density altitude, wind velocities, and weather coupled with the significant physical characteristics like compartmentalization, channelization, and steep terrain drastically influence helicopter-borne operations. The airspace required for aircraft to maneuver will increase and take longer due to decreased aircraft performance capacities with the desired space potentially being unavailable due to terrain implications.⁴⁶ Helicopters may also not have the ability to simply overfly terrain at higher altitudes due to aircraft performance limitations resulting from a high density altitude. This, along with terrain components, will have an impact on ingress and egress routing, airspace coordination measure planning, objective area operations, attack geometry for ordnance delivery, and timing. Terrain, weather, and altitude may limit or influence the size, number, proximity to the objective, and ingress/egress routes of landing zones.⁴⁷ The open and expansive terrain of the desert which will enable multiple aircraft and multiple waves to quickly land and takeoff may not be afforded in mountainous terrain. Multiple landing zones may have to be designated within relative proximity to the objective and each will potentially have its own physical, environmental, and tactical considerations. Ground composition to include snow packs, vegetation, and large obstacles in perspective landing zones will also present significant challenges.⁴⁸ Slope angles will prevent helicopters from landing directly and alternate means such as single and main mount landings, fast roping, and hoist operations may have to be employed. Communications will be affected due to line of site constraints which will in turn affect timing of the delivery of fires, landing zone operations, and other reporting/requesting requirements.

These tactical implications are rarely experienced individually but collectively and are indicative of the complexity of conducting helicopter-borne operations in a mountainous environment underscoring the need for the Marine Corps assault support community to possess a consistent capability. Helicopter-borne operations are not impossible in mountainous terrain and at higher altitudes. The importance of having a practical understanding of this extreme environment cannot be overstated. By having knowledge and recognition of the significant impacts on operations imposed by this environment, the Marine Corps will have a greater ability to plan, prepare, and execute mountain warfare operations.

Current State of Assault Support Readiness

General James Amos, 35th Commandant of the Marine Corps, stated in his planning guidance for 2010 that, “Marines are ready to respond whenever the Nation calls... ready to deploy to any clime or place with little, if any, notice... wherever the President may direct”.⁴⁹ The severe nature of complex, compartmentalized, and mountainous terrain poses substantial challenges to the Marine Corps as a whole and to a MAGTF across all six warfighting functions. Although this environment falls into “any clime and place”, the Marine Corps is currently ill prepared, collectively untrained, and maintains no consistent capability to execute operations in this demanding environment.

The Marine Corps’ current mountain warfare capability essentially amounts to zero based on the “we’ll figure it out when we get there” and Marines will make it happen to meet the mission mentalities. Capabilities across all elements of the MAGTF are virtually non-existent. There is essentially no standardization or requirement to train and educate Marines in this dynamic environment. Unfortunately, this scenario has played out time and again such as in

Korea in 1950 and Afghanistan in 2004. The stop-gap momentary fix is the Marine Corps' typical remedy for most situations such as the reactionary establishment of the Marine Corps Mountain Warfare Training Center in 1951 as a result of cold weather casualties and mountaineering difficulties experienced in Korea.⁵⁰ However, the capacities are generally short lived and quickly atrophy. Very little if any resources and effort are allocated toward the eventual likelihood to conduct operations across the full spectrum of warfare against asymmetric and hybrid threats as well as in the conduct of other contingency operations in mountainous regions.

Due to the lack of current training and inconsistent requirements, Marine helicopter crews, on regular occasion, are forced to develop flight experience and proficiency in not only this but other operational environments once deployed. Major Garth Burnett, USMC deployed as a CH-46E pilot with HMM-266 (Reinforced) of the 22nd Marine Expeditionary Unit to the mountainous regions of eastern Afghanistan, and he noted that the squadron had received no training in mountain flying or in areas with exceedingly high density altitudes with significant terrain components prior to deployment.⁵¹ This resulted in a decreased ability to support assigned missions and an increased level of anxiety when flying having not been exposed to a like condition previously.⁵² This and similar situations often result in a diminished or less than optimal support capacity and can have drastic consequences in areas of support to an assigned mission and heavily influence risk aversion/mitigation. In addition to aircraft and flight experience, physiological impacts such as hypoxia, dehydration, and spatial disorientation as result of the combined effects of pilotage and environmental impacts also often go unaddressed.

Conducting helicopter-borne operations in the mountainous environment requires an understanding of the operating environment and its effects on aircraft, tactical implications, and a

practical application of aviation skills within it.⁵³ Currently, the Marine assault support community does not train and prepare for operations in these extreme conditions. For example, the *CH-53E T&R Manual* requires four academic and six individual flight Mission Essential Tasks (MET) described as Confined Area Landings (CAL) or Mountain Area Landings (MAL).⁵⁴ The operating conditions for these METs are loosely defined, and once complete, aircrews are deemed sufficiently trained to conduct operations in mountainous environs. With the exception of the *MV-22B T&R Manual* which nominally describes 6,000 feet, not specific to density altitude, pressure altitude, or mean sea level, the required METs of each Type/Model/Series (T/M/S) helicopter is virtually the same.⁵⁵ Moreover, there is no Pre-deployment Training Program plan with defined training and operational requirements or demonstration of proficiency to execute missions in conditions relevant to the mountainous environment.

MAGTF operations, regardless of the operational environment, require individual and collective training in order to establish proficiency, develop capabilities, and maintain those capabilities in order to effectively operate. The Pakistan Army routinely operates in the Kashmir region and northern Pakistan. Major Muhammad Asim Malik of the Pakistan Army identifies the tactical necessity for having the capability to conduct helicopter-borne operations in mountainous environments. "Aviation is critical to mobility, timely logistics, and precision firepower. Pilots should be well trained in mountain flying and in understanding an infantryman's problems in mountainous terrain."⁵⁶ By understanding the operational environment and identifying required capabilities, the Pakistan Army leverages resources and training in order to operate successfully within it. The Marine Corps should take notice and commit to the same.

Every mission is critical to success of an operation, and the aviator must not be the limiting factor. An understanding and mitigation of specific aircraft limitations and capabilities based on environmental effects is essential to successful helicopter-borne operations in the mountainous environment. The Marine Corps must establish long-term depth and continuity in experience and training within the assault support community across all aircraft types. This will allow for long term consistent capabilities and tactical proficiency.

Existing Models

The U.S. Department of Defense operates two mountain aviation formal schools in support of the individual air crewman and unit training. The U.S. Army operates the High Altitude Aviation Training Site (HAATS), and the U.S. Navy operates the Mountain Flying Course through the Naval Strike Air Warfare Center (NSAWC). While the HAATS course focuses primarily on pre-deployment individual and unit training, the NSAWC course focuses specifically on individual aircrew training. Both programs emphasize a holistic approach to helicopter-borne operations in the mountainous environment by providing classroom instruction and practical application in the key areas of mountain weather, terrain, and aircraft performance based on power management. The bottom line is that aircrews are trained in operating effectively within the constraints of the environment. Allied and coalition partners, many of which have mountainous regions within their home countries emphasize mountain flying skills in their helicopter pilot training. The Canadian, Pakistani, and Nepalese Armies all have helicopter units skilled in mountain operations, maintain a robust capability to carry out a wide range of military operations, and in many cases have a greater ability to operate than the Marine Corps.

A fact of concern is that potential foes have invested in helicopter-borne training. The Chinese have fielded an aviation brigade in the Xinjiang Military region based in the Tianshan Mountains and operate former Soviet Union and current Russian transport and attack helicopters.⁵⁷ Similarly, North Korea and Iran both possess substantial helicopter-borne capabilities, and the assumption can be made for numerous other states with mountainous regions inside or near their borders. This notion should reinforce the need to not only possess the capability, but have a greater capability than that of a potential enemy.

Way Ahead-Recommendations

The *Marine Corps Mountain Warfare Operations (MWO) T&R Manual* provides the Marine Corps Task (MCT) 1.6.9, Conduct Mountain Warfare Operations, establishes the associated Mission Essential Task List (METL), and defines the operational conditions. Though this is an infantry-centric T&R Manual, the operational conditions should be reflective of the entire MAGTF and associated warfighting publications as it does contain helicopter-borne and MAGTF level tasks. The *MWO T&R Manual* defines complex, compartmentalized, and mountainous terrain and is indicative of the overall operating conditions and characteristics provided in *Mountain Warfare Operations*.⁵⁸

Elevation (MSL)		Slope Angle	Temperature Bands	
Very High	>10,000 ft	0 to 90° Vertical w/	Wet Cold	+40 to +20°F
High	6,000 to 10,000 ft	20 to 60° Common	Dry Cold	+20 to -5°F
Moderately High	3,000 to 6,000 ft		Intense Cold	-5 to -25°F
			Extreme Cold	-25 to -60°F

Figure 4

Marine Corps Training and Readiness (T&R) Manuals have to be re-examined, streamlined, and standardized across all helicopter Type/Model/Series (T/M/S) in order to

establish the training baseline and training conditions for each task to be completed in a mountainous environment. Currently, each T/M/S has varying tasks associated with Confined Area Landings (CALS), Mountain Area Landings (MALS), or Mountain Area Training (MAT) but little else. The operational condition is either loosely defined or not defined at all. The operational condition must first be standardized across the entire Marine Corps assault support community in order to establish key tasks to be accomplished for maximum training and mission capability.

The current *Mountain Warfare Operations T&R Manual* condition serves as the best definition for the Marine Corps helicopter and tilt-rotor T&R Manual conditions as it meets the required operating condition and is inclusive and simple. The condition for each of these T&R Manuals in the conduct of mountain area Mission Essential Tasks (MET) should contain the previously described terrain criteria for slope angles and elevations described as “High”. For aviation operations, the altitude should be reflected as density altitude vice elevation above mean sea level. This will allow for greater flexibility in training locations while retaining the necessary environmental qualities and terrain requirements. The terminology for all aircraft types should be and identified as Mountain Area Training (MAT) with individual METs codified under this common category.

Modification to aviation T&R Manuals is always a contentious debate. This is primarily centered on concerns that requirements are already too vast to account for the development and maintenance of combat capable pilots while maintaining squadron core competencies in addition to aircraft and resource availability.⁵⁹ Therefore, additional MAT events should be placed in the Core Plus Skill Phase of training similar to Carrier Qualifications (CQ). This will allow for the greatest flexibility in requirements for deploying units or detachments and Marine Expeditionary

Unit detachments. Training and Readiness METs should reflect specific and basic events. Each T/M/S T&R manager will have to distinguish additional tactical requirements for inclusion in the Core Plus Skill Phase as appropriate for each T/M/S in line with core competencies and mission requirements adding or adjusting Core Basic Skill Phase events utilizing the MAT condition. These can include events such external load operations, simulated close air support, and tactical escort. Squadrons should also be directed to utilize the existing U.S. Army and U.S. Navy institutions to train and maintain resident experience in the instructor pilot cadre. Executing these basic events in the dynamic mountainous environment will better prepare individual aircrew in the execution of Pre-deployment Training Program (PTP) and future combat missions.

A Pre-deployment Training Program should be developed to refine current capabilities and gain capabilities in the support of likely missions to be conducted. Currently, the Marine Corps utilizes Enhanced Mojave Viper (EMV) for deploying units to current theaters of operation and Special Operations Training Group (SOTG) to prepare Marine Expeditionary Units (MEU) for deployment. Given that mountainous regions are in close proximity to numerous littoral areas, SOTG should develop training programs for MEUs and their aviation detachments that require training, in part, in a mountainous environment. This recommendation is reinforced by the 15th MEU conducting Disaster Relief (DR) Operations in Pakistan in 2010 with numerous operations conducted at high altitudes. Enhanced Mohave Viper should adapt its training program accordingly as the global situation and long term Marine deployment cycles evolve.

The combination of individual preparedness and unit preparedness will directly translate to an increased capability to operate successfully in the mountainous environment. The Marine Corps Mountain Warfare Training Center in Pickel Meadow, California is the only Marine Corps

installation that provides expert training facilities and personnel. However, it is grossly underutilized and is primarily frequented by other DOD services. The Marine assault support communities, whether individually and or as part of a directed PTP requirement, should utilize this valuable asset in order to increase squadron and individual competencies. The enemy is not always living and breathing, but it is also the environment itself.

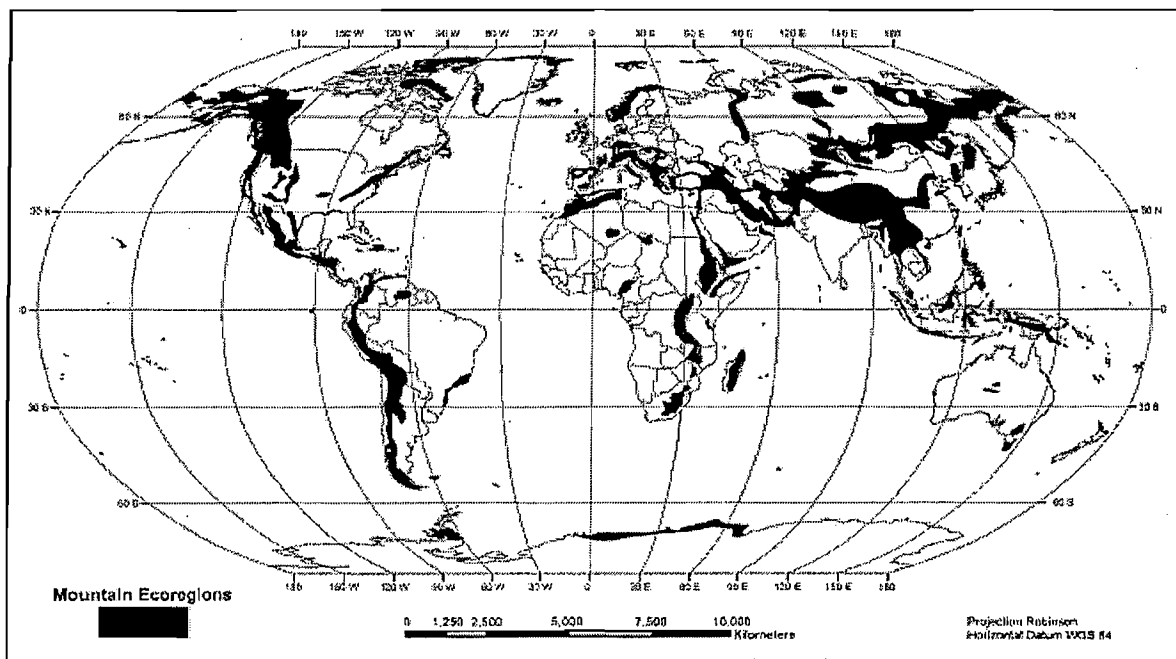
Conclusion

The coming years will inevitably take the Marine Corps to battlefields and other contingency locations in mountains regions. Again, it is not a matter of if, but when. It will serve the Marine Corps and the nation well to have an expeditionary force in readiness prepared and with a sustained capability to operate in this environment. Supported by recent operations over the past decade, the Marine Corps must invest in capabilities across the MAGTF in order to effectively execute missions in the mountainous environment.

Strategic, operational, and tactical conditions exist that require the Marine Corps to possess the resident capabilities to operate and support the eventuality that a MAGTF will be employed in this demanding environment. Consequently, the dynamic and formidable characteristics of the mountainous operational environment with associated implications on MAGTF operations, specifically helicopter-borne operations, are substantial. Moreover, the current state of Marine assault support capabilities to operate in the mountainous environment is virtually non-existent, and must be rectified. As a major subordinate element of the MAGTF, the Air Combat Element (ACE), specifically the helicopter and tilt-rotor assets of the assault support community, must develop and maintain resident competencies to conduct helicopter-borne operations in the mountainous operational environment. The Marine Corps must

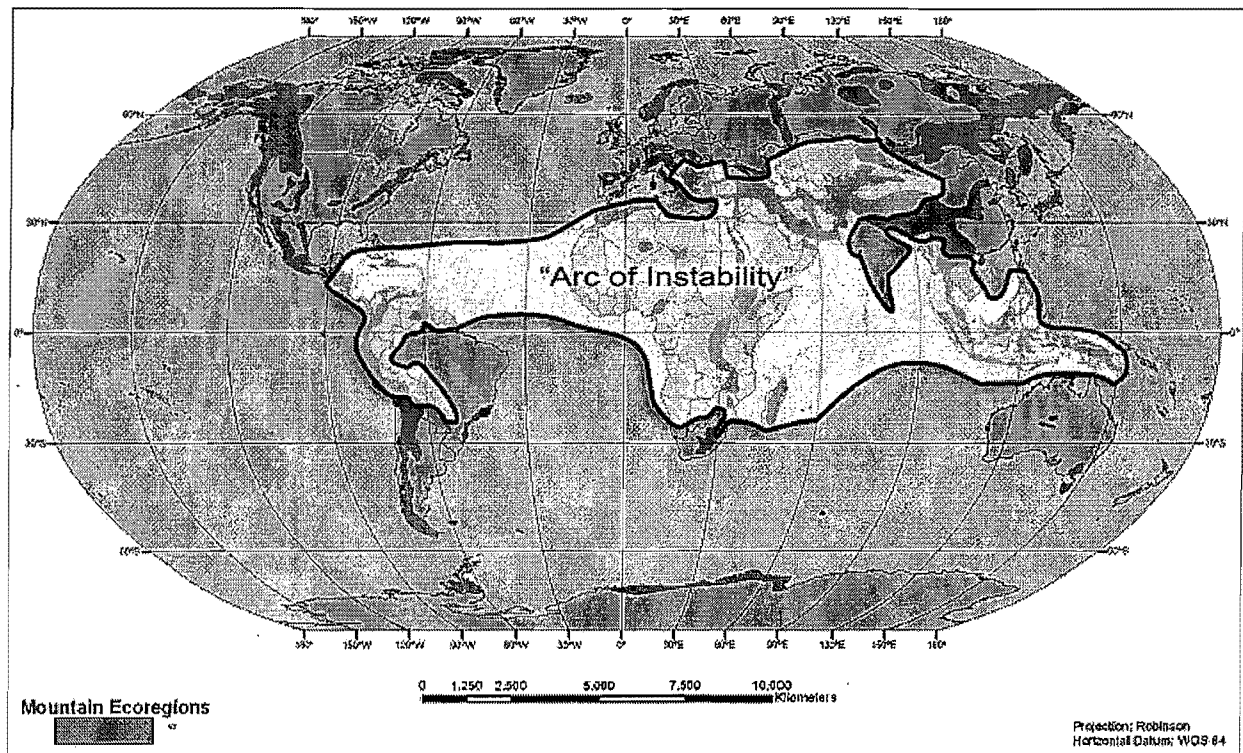
recognize and commit to this necessity across all elements of the MAGTF. Overlooking this requirement puts the Marine Corps and the nation in jeopardy. Prepared to deploy world-wide in a moment's notice and to any clime and place, the Marine Corps had better be ready to do so.

APPENDIX A



Source: U.S. Marine Corps, *Mountain Warfare Operations*, MCWP 3-35.1.⁶⁰

APPENDIX B



Source: U.S. Marine Corps, *Mountain Warfare Operations*, MCWP 3-35.1.⁶¹

Notes

¹ U.S. Army National Guard, High-Altitude Army Training Site, *HAATS Training Manual* (Eagle, CO: ARNG, March 2009), i.

² Normal Cooling, personal interview with the author, July 2008.

³ The six warfighting functions are maneuver, fires, sustainment, command and control, force protection, and intelligence. They describe operational requirements for military forces across the spectrum of conflict and relate operations to specific functions and sub-functions within each. These six functions often overlap and are used for operational planning and execution. Scott Pierce, "Mountain and Cold Weather Warfighting: Critical Capability for the 21st Century," (monograph, School of Advanced Military Studies, United States Army Command and General Staff College, 2008), 13, <http://www.dtic.mil/dtic/tr/fulltext/u2/a485557.pdf>

⁴ United Nations Environment Programme-World Conservation Monitoring Centre. Mountain Watch: Environmental Change & Sustainable Development in Mountains (Cambridge, UK: UNEP-WCMC, January 2002), 8, http://www.unepwcmc.org/medialibrary/2010/09/10/71bb554a/Mountain_Watch.pdf. (accessed December 22, 2011).

⁵ U.S. Secretary of Defense, *Quadrennial Defense Review Report 2010*, Arlington, VA: Department of Defense, February 2010. http://www.defense.gov/qdr/images/QDR_as_of_12_Feb10_1000.pdf, 28 (accessed January 4, 2011).

⁶ Maria Kruse, "Working for Peace in the Mountains: International Mountain Day 2004," Food and Agriculture Organization of the United Nations, 2004. <http://www.fao.org/newsroom/en/news/2004/51883/index.html>. (accessed January 4, 2011).

⁷ Headquarters U.S. Department of the Army, and Headquarters U.S. Marine Corps, *Mountain Warfare Operations*, ATTP 3-97.6 or MCWP 3-35.1 *Draft* (Washington, DC: U.S. Department of the Army, December 2010), 10.

⁸ *Mountain Warfare Operations*, 8. The 20 states of interest include: Afghanistan, Albania, Bangladesh, China, Columbia, Ethiopia, Georgia, Haiti Indonesia, Iran, Iraq, Liberia, Mauritania, Nigeria, North Korea, Pakistan, Philippines, Saudi Arabia, Syria, and Uzbekistan. Headquarters U.S. Marine Corps, Marine Corps Intelligence Activity, *Marine Corps Midrange Threat Estimate 2005-2015*, MCIA-1586-011-05 (Washington, DC: U.S. Department of Defense, July 2005), A3-A21.

⁹ Thomas P.M. Barnett, *The Pentagon's New Map: War and Peace in the Twenty-First Century* (New York: G.P Putnam's and Sons, 2004), 179-190.

¹⁰ The Zagros Mountains stretch from the border with Armenia and Iraq in the northwest to the Persian Gulf and eastward into Pakistan. Farther south, the range broadens into a band of parallel ridges 125 miles wide lying between the plains of Iraq and the central plateau of Iran. The region is extremely rugged and difficult to access. The Elburz Mountains run along the south shore of the Caspian Sea meeting the border regions in eastern Iran and has consistent elevations exceeding 18,000 feet. This region contains the majority of Iran's oil and natural gas supplies, the state's primary export and economic foundation. Encyclopedia Britannica Academic Edition, s.v. "Iran." <http://www.britannica.com/EBchecked/topic/293359/> (accessed February 13, 2012).

¹¹ Headquarters U.S. Marine Corps, Marine Corps Intelligence Activity, *Marine Corps Midrange Threat Estimate: 2005-2015*, MCIA-1586-001-05 (Washington, DC: U.S. Department of Defense, July 2005), A-1.

¹² 34th Commandant of the Marine Corps, *Marine Corps Vision and Strategy 2025* (Washington, DC: Headquarters, U.S. Marine Corps, 2008), 5,15.

¹³ East and Southeast Asia Littorals (US PACOM); Red Sea, Arabian Gulf, and Arabian Sea Littorals (US CENTCOM); East and West Africa Littorals (US AFRICOM); Latin America and the Caribbean Basin (US SOUTHCOM); and Mediterranean Sea/North Africa Littorals (US EUCOM/AFRICOM). *Marine Corps Vision and Strategy 2025*, vii.

¹⁴ James F. Amos, "Reshaping America's Expeditionary Force in Readiness Report of the 2010 Marine Corps Force Structure Review Group," *Marine Corps Gazette* 95, no. 5 (May 3011): 15.

¹⁵ Garth Burnett, personal interview with the author, January 16, 2011.

¹⁶ The Soviet Comparison: The expeditionary, maneuver warfare, and combined arms philosophies of the Marine Corps were employed to great effect by the Soviets during their invasion of Afghanistan. Between 1980 and 1981, Soviet military leadership began to fully recognize the effect of the Mujahedeen and the environment on combat operations and subsequently reorganized and equipped Soviet forces increasing the number of helicopters from 60 to approximately 300. Highly trained airborne troops primarily deployed by helicopter provided significant mobility and allowed employment of the element of surprise more often than not with the most effective fire support,

resupply, and reinforcements provided by other helicopter assets. The Soviets conducted a number of battalion-sized helicopter-borne air assaults inserting maneuver units and organic artillery into the rugged mountainous terrain in order to envelop the Mujahedeen. Soviet doctrine relied heavily on combined arms utilizing organic fire support assets as well as aviation based platforms, both helicopters and fixed wing aircraft. Although, efficiency and success matured over time, their operations became highly successful in the most austere, rugged, and mountainous regions. Victor Maduka, "Considerations for Employment of Marine Helicopters in Future Conflicts: How Much Risk is Acceptable?" (Masters Thesis, Marine Corps University, 2008), 8.

¹⁷ Headquarters U.S. Department of the Army, *Infantry Small-Unit Mountain Operations*. ATTP 3-21.50 (Washington, DC: U.S. Department of the Army, February 2011), 1-4.

¹⁸ *Infantry Small-Unit Mountain Operations*, 1-5.

¹⁹ *Mountain Warfare Operations*, 11.

²⁰ *Mountain Warfare Operations*, 11.

²¹ *Mountain Warfare Operations*, 13.

²² *Mountain Warfare Operations*, 13.

²³ Pierce, 12.

²⁴ Headquarters U.S. Department of the Army, *Mountain Operations*, FM 3-97.6. (Washington, DC: U.S. Department of the Army, November 2000) 1-6.

²⁵ *Mountain Operations*, 1-5.

²⁶ Headquarters U.S. Department of the Army, and Headquarters U.S. Marine Corps, *Cold Region Operations*, ATTP 3-97.11 or MCWP 3-35.1D (Washington, DC: U.S. Department of the Army, January 2011), 1-7.

²⁷ *Mountain Operations*, 1-6.

²⁸ *HAATS Training Manual*, 2-1.

²⁹ *HAATS Training Manual*, 2-1.

³⁰ *HAATS Training Manual*, 2-3.

³¹ *HAATS Training Manual*, 2-3.

³² *HAATS Training Manual*, 2-5.

³³ *Mountain Operations*, 1-7.

³⁴ *Mountain Operations*, 1-8.

³⁵ *Mountain Operations*, 1-7.

³⁶ *Mountain Operations*, 1-8.

³⁷ Naval Air Training Command, Chief of Naval Air Training, *Introduction to Helicopter Aerodynamics TH-57*, Instruction P-401, October, 7 2009, 8-1, <https://www.cnatra.navy.mil/pubs/folders/TH57/P-401.pdf>. (accessed December 27, 2011).

³⁸ Scott Broberg, "Are We Properly Prepared for Helicopter Operations in Afghanistan?" *Marine Corps Gazette* 86, no. 5 (May 2002): 70, <http://www.proquest.com/>.

³⁹ *Introduction to Helicopter Aerodynamics TH-57*, 1-14.

⁴⁰ *HAATS Training Manual*, 1-3.

⁴¹ *HAATS Training Manual*, 2-17.

⁴² U.S. Marine Corps, Marine Aviation Weapons and Tactics Squadron One, *Marine Corps Air Assault Operations*, MCIP 3-24.01 Draft (Yuma, AZ: MAWTS-1, January 2011), Section 9.

⁴³ *Marine Corps Air Assault Operations-Draft*, Section 9.

⁴⁴ *HAATS Training Manual*, 1-3.

⁴⁵ *HAATS Training Manual*, 1-2.

⁴⁶ *Marine Corps Air Assault Operations-Draft*, Section 9.

⁴⁷ *Marine Corps Air Assault Operations-Draft*, Section 9.

⁴⁸ *Marine Corps Air Assault Operations-Draft*, Section 9.

⁴⁹ 35th Commandant of the Marine Corps, *Commandant's Planning Guidance* (Washington, DC: Headquarters, U.S. Marine Corps, 2010), 5-6.

⁵⁰ "Marine Corps Mountain Warfare Training Center," *Marines Magazine Online*, October 11, 2011.

<http://marinesmagazine.dodlive.mil/2011/10/18/marine-corps-mountain-warfare-training-center> (accessed February 7, 2012).

⁵¹ Burnett, January 16, 2011.

⁵² Burnett, January 16, 2011.

⁵³ Bart A. Betik, "Aviation in the Mountains: Training Marine Aviators for Operations in Complex, Compartmentalized, and Mountainous Terrain," *Marine Corps Gazette* 94, no. 9 (September 2010): 42.

⁵⁴ Commandant of the Marine Corps, *CH-53 Training and Readiness Manual*, NAVMC 3500.47A, March 8, 2011.

⁵⁵ Commandant of the Marine Corps, *MV-22B Training and Readiness Manual*, NAVMC 3500.11B, March 10, 2010.

⁵⁶ Muhammad A. Malik, "Mountain Warfare-The Need for Specialized Training," *Mountain Warfare and Other Lofty Problems: Foreign Perspectives On High-Altitude Combat*, ed. Lester W. Grau and Charles K. Bartles (Fort Leavenworth, KS: Foreign Military Studies Office, 2011), 26.

⁵⁷ "Xinjiang Military Region Army Aviation Base In the Mountains: The Implementation of a Low Altitude Helicopter Raid," 9abc.net, September 4, 2011. <http://www.9abc.net/index.php/archives/41476> (accessed January 17, 2012).

⁵⁸ Commandant of the Marine Corps, *Mountain Warfare Operations Training and Readiness Manual*, NAVMC 3500.70, August 12, 2009, 3-3.

⁵⁹ Betik, 42.

⁶⁰ *Mountain Warfare Operations*, 10.

⁶¹ *Mountain Warfare Operations*, 10.

Bibliography

- 34th Commandant of the Marine Corps. *Marine Corps Vision and Strategy 2025*. Washington, DC: Headquarters, U.S. Marine Corps, 20108.
- 35th Commandant of the Marine Corps. *Commandant's Planning Guidance*. Washington, DC: Headquarters, U.S. Marine Corps, 2010.
- Amos, James F. "Reshaping America's Expeditionary Force in Readiness Report of the 2010 Marine Corps Force Structure Review Group." *Marine Corps Gazette* 95, no. 5 (May 3011): 13-16.
- Barnett, Thomas P.M. *The Pentagon's New Map: War and Peace in the Twenty-First Century*. New York: G.P Putnam's and Sons, 2004.
- Betik, Bart A. "Aviation in the Mountains: Training Marine Aviators for Operations in Complex, Compartmentalized, and Mountainous Terrain." *Marine Corps Gazette* 94, no. 9 (September 2010): 41-43.
- Broberg, Scott. "Are We Properly Prepared for Helicopter Operations in Afghanistan?" *Marine Corps Gazette* 86, no. 5 (May 2002): 70-74. <http://www.proquest.com/>.
- Commandant of the Marine Corps. *CH-53 Training and Readiness Manual*. NAVMC 3500.47A, March 8, 2011.
- Commandant of the Marine Corps. *Mountain Warfare Operations Training and Readiness Manual*. NAVMC 3500.70, August 12, 2009.
- Commandant of the Marine Corps. *MV-22B Training and Readiness Manual*. NAVMC 3500.11B, March 10, 2010.
- Headquarters U.S. Department of the Army. *Mountain Operations*. FM 3-97.6. Washington, DC: U.S. Department of the Army, November 2000.
- Headquarters U.S. Department of the Army, and Headquarters U.S. Marine Corps. *Cold Region Operations*. ATTP 3-97.11 or MCWP3-35.1D. Washington, DC: U.S. Department of the Army, January 2011.
- Headquarters U.S. Department of the Army. *Infantry Small-Unit Mountain Operations*. ATTP 3-21.50. Washington, DC: U.S. Department of the Army, February 2011.
- Headquarters U.S. Department of the Army. *Mountain Operations*. FM 3-97.6. Washington, DC: U.S. Department of the Army, November 2000.
- Headquarters U.S. Department of the Army, and Headquarters U.S. Marine Corps. *Mountain Warfare Operations*. ATTP 3-97.6 or MCWP3-35.1 *Draft*. Washington, DC: U.S. Department of the Army, December 2010.

- Headquarters U.S. Marine Corps, Marine Corps Intelligence Activity. *Marine Corps Midrange Threat Estimate: 2005-2015*. MCIA-1586-001-05. Washington, DC: U.S. Department of Defense, July 2005.
- Headquarters U.S. Marine Corps. *Marine Corps Operations*. MCDP 1-0. Washington, DC: U.S. Marine Corps, August 9, 2011.
- Kruse, Maria. "Working for Peace in the Mountains: International Mountain Day 2004." Food and Agriculture Organization of the United Nations 2004.
<http://www.fao.org/newsroom/en/news/2004/51883/index.html>. (accessed January 4, 2012).
- Maduka, Victor. "Considerations for Employment of Marine Helicopters in Future Conflicts: How Much Risk is Acceptable?" Masters Thesis, Marine Corps University, 2008.
- Malik, Muhammad A. "Mountain Warfare-The Need for Specialized Training." *Mountain Warfare and Other Lofty Problems: Foreign Perspectives On High-Altitude Combat*, edited by Lester W. Grau and Charles K. Bartles, 15-29. Fort Leavenworth, KS: Foreign Military Studies Office, 2011.
- "Marine Corps Mountain Warfare Training Center." *Marines Magazine Online*. October 11, 2011. <http://marinesmagazine.dodlive.mil/2011/10/18/marine-corps-mountain-warfare-training-center> (accessed February 7, 2012).
- Naval Air Training Command, Chief of Naval Air Training. *Introduction to Helicopter Aerodynamics TH-57*. Instruction P-401, October 7, 2009.
<https://www.cnatra.navy.mil/pubs/folders/TH57/P-401.pdf>. (accessed December 27, 2011).
- Pierce, Scott W. "Mountain and Cold Weather Warfighting: Critical Capability for the 21st Century." Monograph, School of Advanced Military Studies, United States Army Command and General Staff College, 2008.
<http://www.dtic.mil/dtic/tr/fulltext/u2/a485557.pdf>.
- Urban, Mark. *War in Afghanistan*. New York: St. Martin's Press Inc, 1988.
- United Nations Environment Programme-World Conservation Monitoring Centre. *Mountain Watch: Environmental Change & Sustainable Development in Mountains*. Cambridge, UK: UNEP-WCMC, January 2002.
http://www.unepwcmc.org/medialibrary/2010/09/10/71bb554a/Mountain_Watch.pdf. (accessed December 22, 2011).
- U.S. Army National Guard, High-Altitude Army Training Site. *HAATS Training Manual*. Eagle, CO: ARNG, March 2009.
- U.S. Department of Defense. *Dictionary of Military and Associated Terms*. Joint Publication 1-02. Washington, DC: Joint Staff, November 8, 2010.
- U.S. Department of Defense. *Quadrennial Defense Review Report 2010*. Arlington, VA: Department of Defense, February 2010.
http://www.defense.gov/qdr/images/QDR_as_of_12_Feb10_1000.pdf. (accessed January 4, 2012).

U.S. Marine Corps, Marine Aviation Weapons and Tactics Squadron One, *Marine Corps Air Assault Operations*, MCIP 3-24.01 *Draft*. Yuma, AZ: MAWTS-1, January 2011.

“Xinjiang Military Region Army Aviation Base In the Mountains: The Implementation of a Low Altitude Helicopter Raid.” 9abc.net, September 4, 2011.
<http://www.9abc.net/index.php/archives/41476> (accessed January 17, 2012).